Research in Support of Nutrient Criteria Development in New Jersey

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401 East State Street
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To Develop Water Quality Protection Tools You Need:

Research: Develop a scientifically defensible nutrient stressor-response model.

Standards: Select criteria supported by defensible science to protect designated uses (aquatic life, recreation, aesthetics)

Monitoring: Cost-effective implementable field lab protocols for routine monitoring in support of short term water quality goals (Bi-annual 305b/303d) and long term restoration goals (TMDLs)

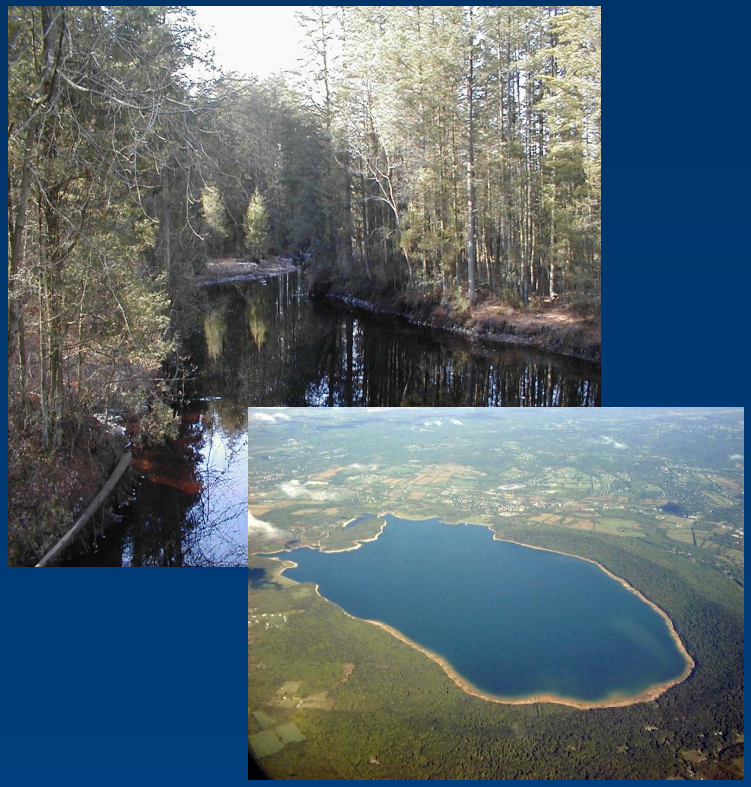
Assessment: Protocols to assess monitoring data for meeting standards recognizing the relationships between water chemistry criteria and biocriteria (TP Vs Chl a and/or biodiversity)

NJ Freshwater Criteria

Narrative Criteria

Nutrients shall not be allowed in concentrations:

- that cause objectionable algal densities
- nuisance aquatic vegetation
- abnormal diurnal fluctuations in dissolved oxygen or pH
- changes to composition of aquatic ecosystems (how much)
- or otherwise render the waters unsuitable for designated uses



Phosphorus Numeric

- Lakes: 0.05 mg/L
- Streams: 0.1 mg/L

Algae Indicators in NJ Streams

Goal

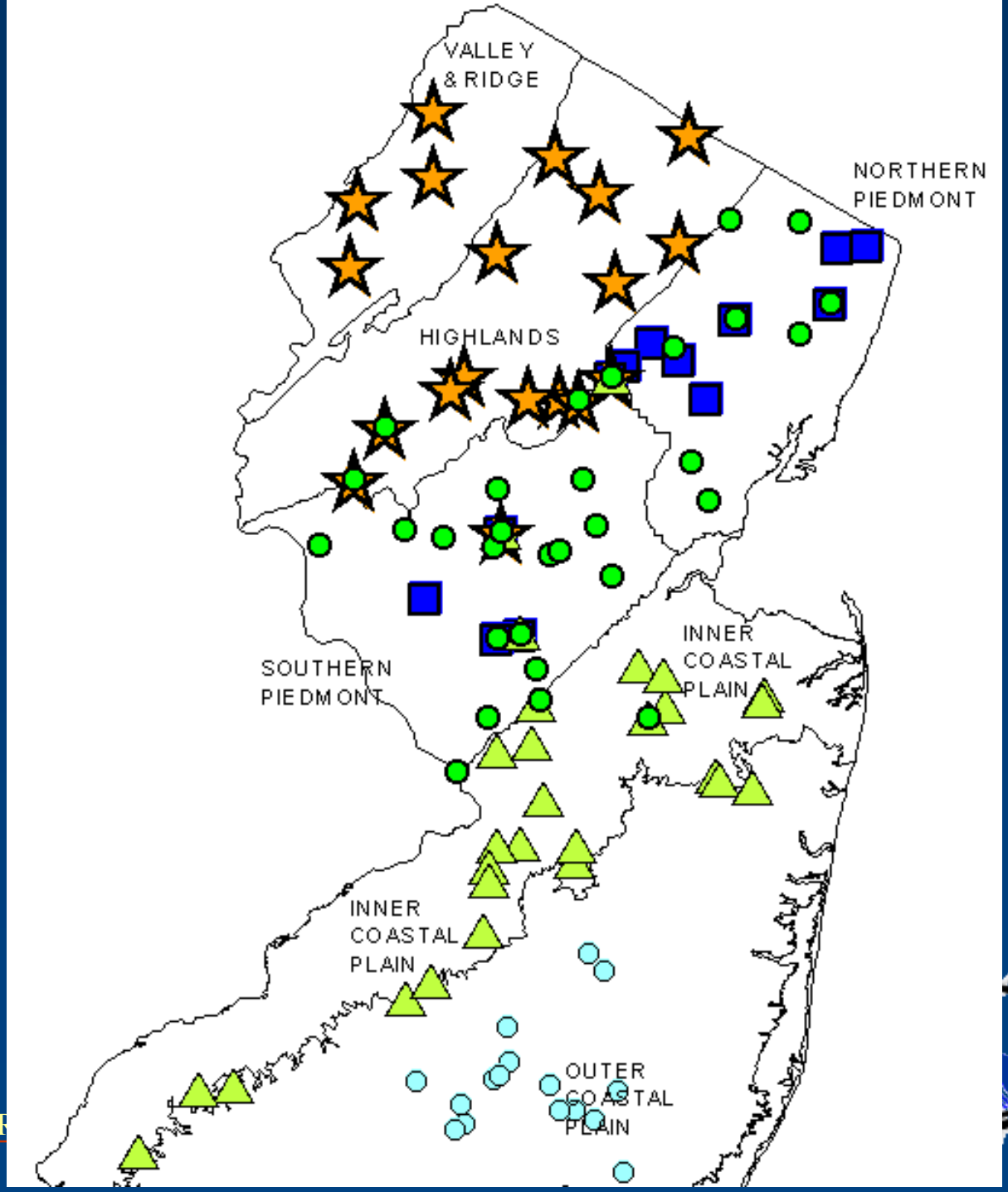
Use algal indicators to identify
levels and causes
of ecological impairment,
primarily those related to
the nutrients phosphorus and nitrogen

Study sites 2000 – 2004

Ponader et al. 2007, 2008

Piedmont	28
Ridge & Val.	5
Highlands	12
Coastal Plain	34

Total: 79 streams



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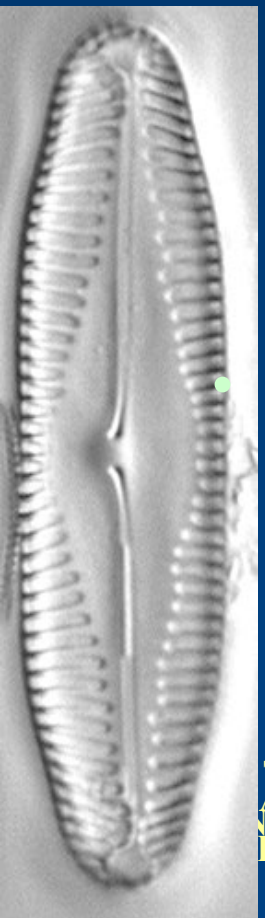
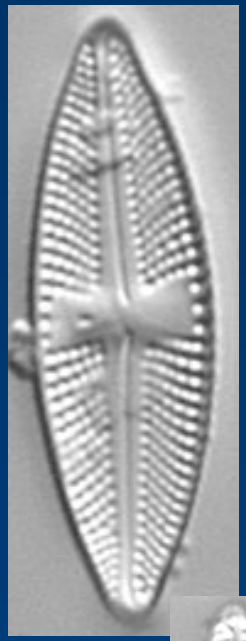
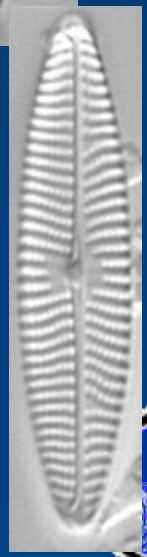
Diatom indicator species high TP

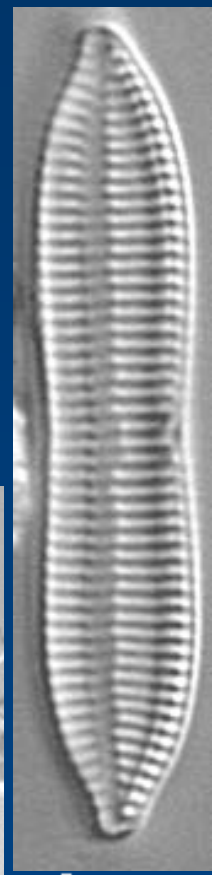
- optima >0.15 mg/l
  - *Luticola goeppertiana* (Bl. i Rabh.) Mann
  - *Tryblionella apiculata* Greg.
  - *Navicula erifuga* Lange-Bert.
  - *Pinnularia microstauron* Ehr. (Cl.)

- optima >0.09 mg/l
  - *Gomphonema kobayasii* Kociolek& Kingston
  - *Navicula ingenua* Hust.
  - *Navicula recens* Lange-Bert.

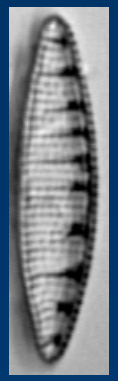


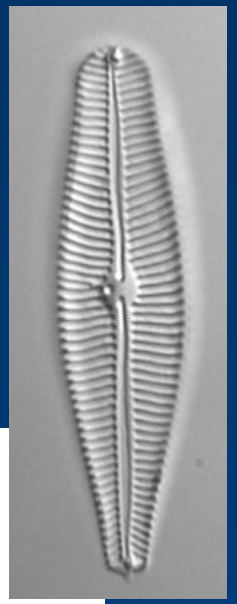


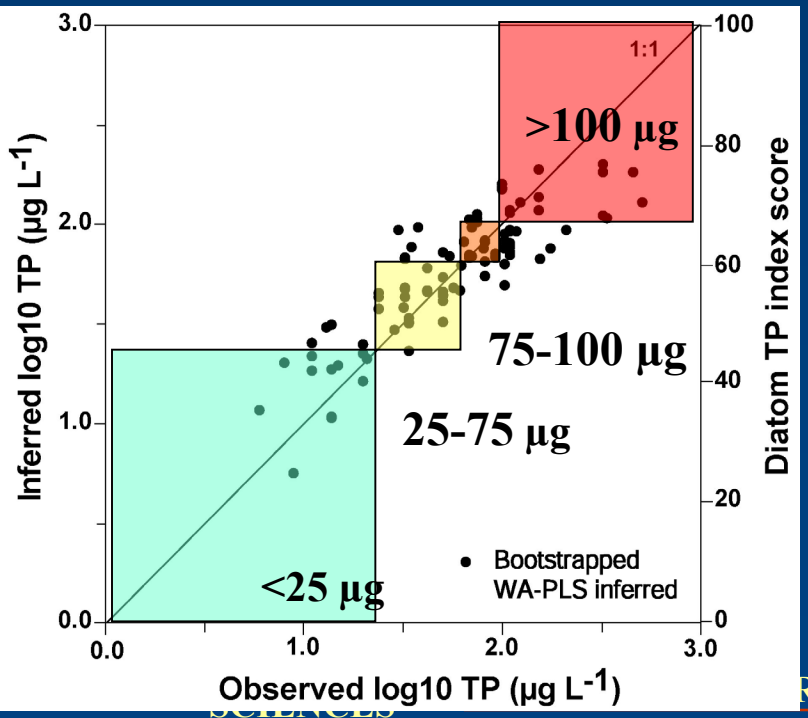


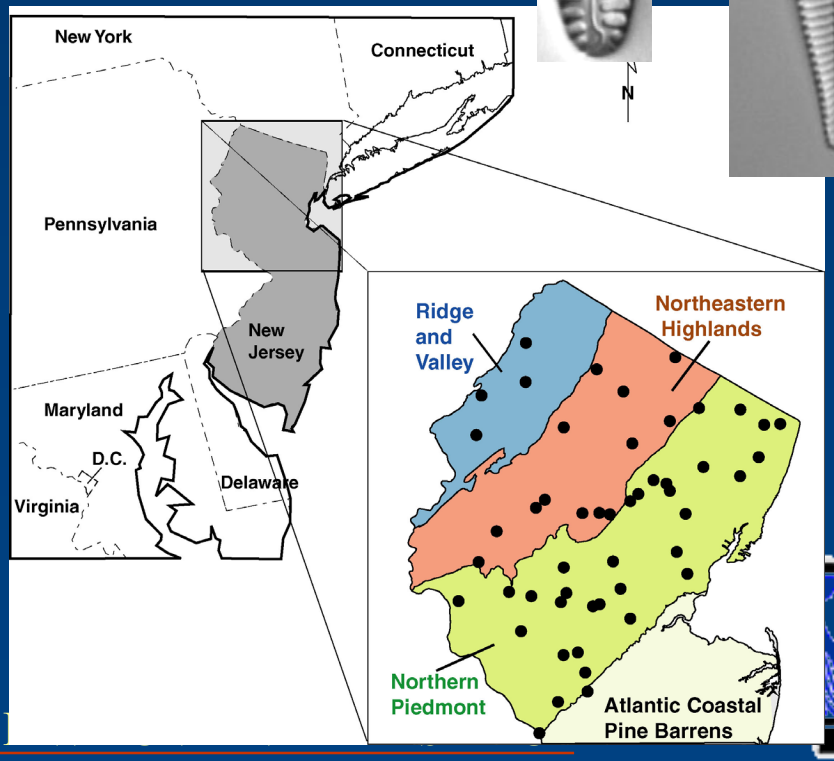


Two Trophic Diatom Indices Developed as Bio-Criteria to Meet EPA Mandate

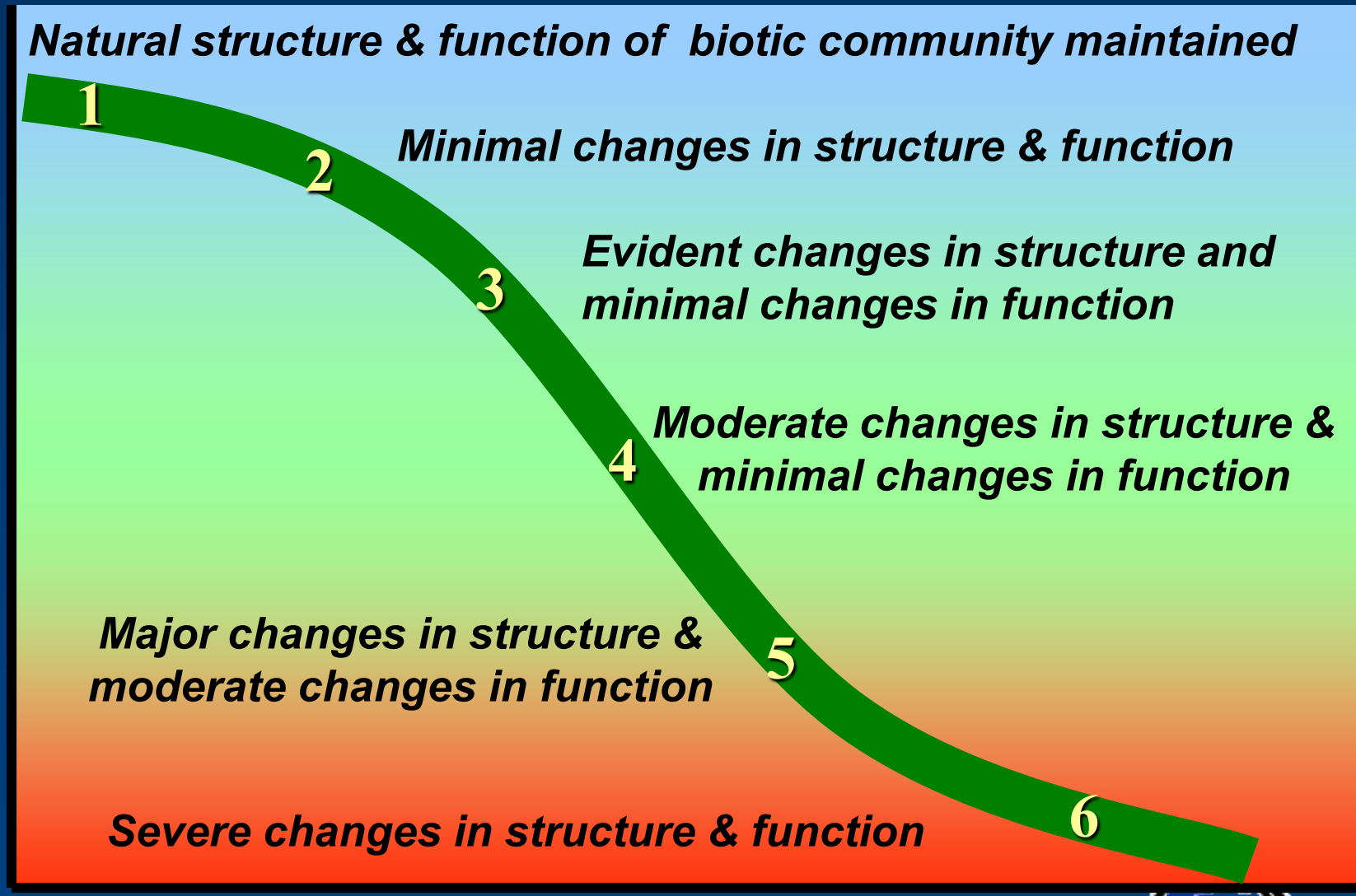






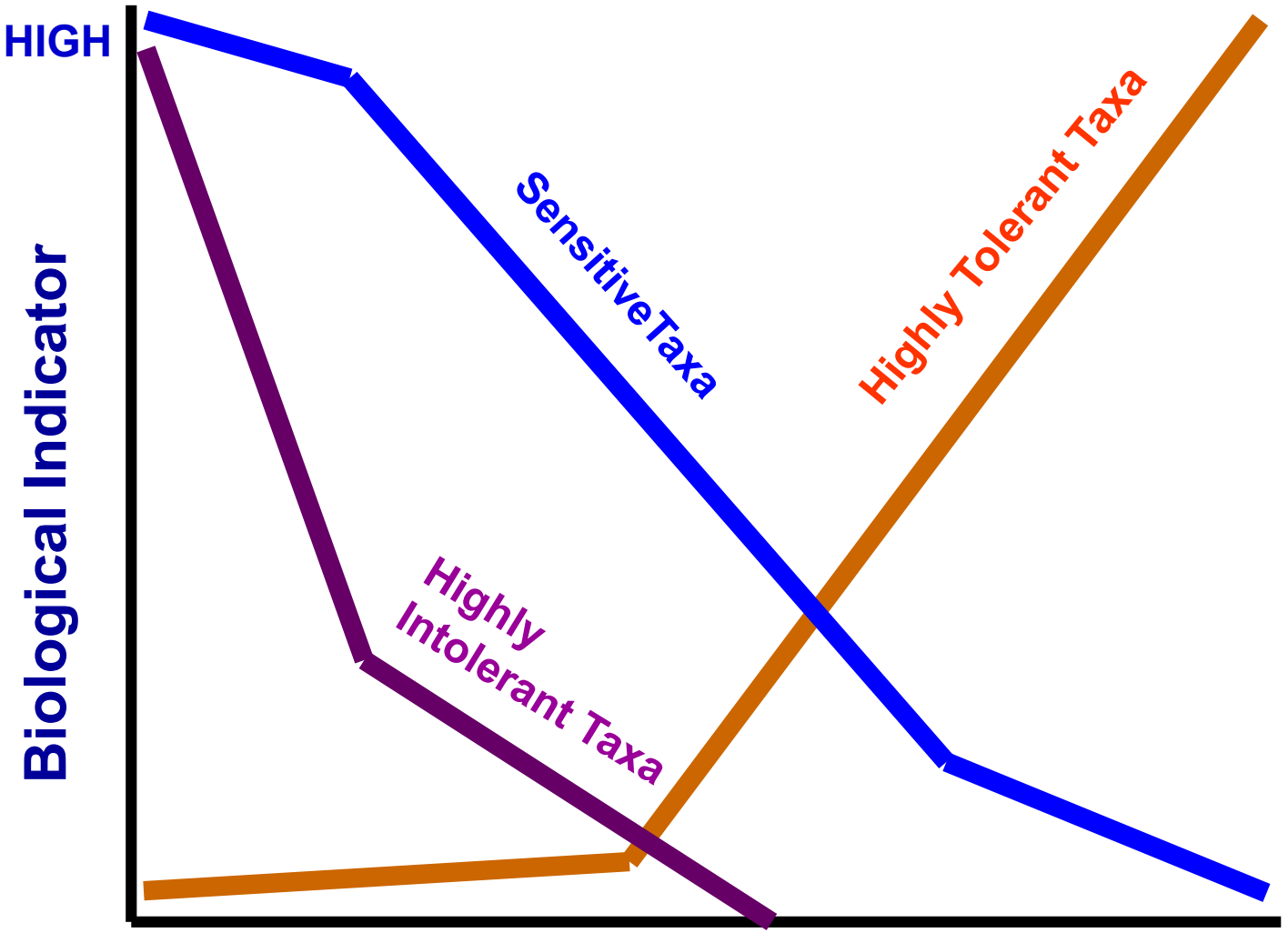


The Biological Condition Gradient – Concept



(Davies and Jackson 2006)

Biological Indicators: Behavior Along the Stressor Gradient



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Modified from Original Courtesy of Chris Yoder, CABB

New Jersey Diatom TALU Workshop – Aug 2009

Assigned 57 diatom counts to BCG Categories

Diatom Experts

Rex Lowe
Kalina Manoylov
Jan Stevenson
Jerry Sgro
Hunter Carrick
Dean DeNicola
Marina Potapova

Facilitator

Jeroen Gerritsen

CH

Nutrient criteria options

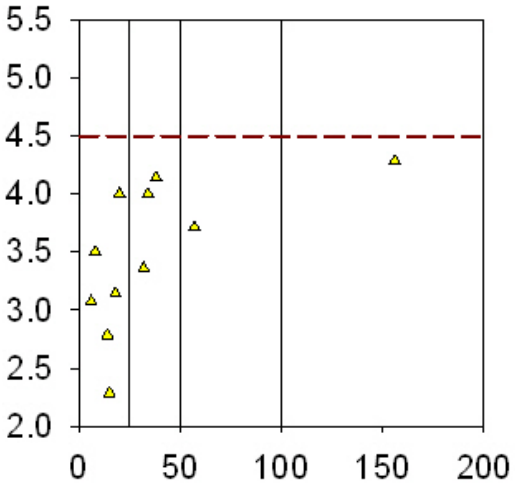
NJ BCG Impairment Boundary

25 - 50 ug/L

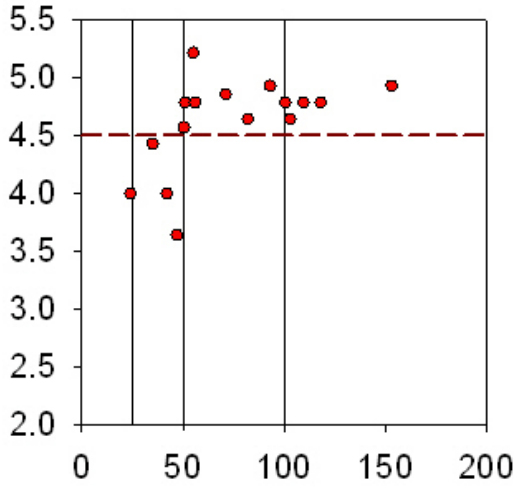
Ave. Diatom Workshop BCG Score

< 30 ug/L

Ridge and Valley / Northern Highlands

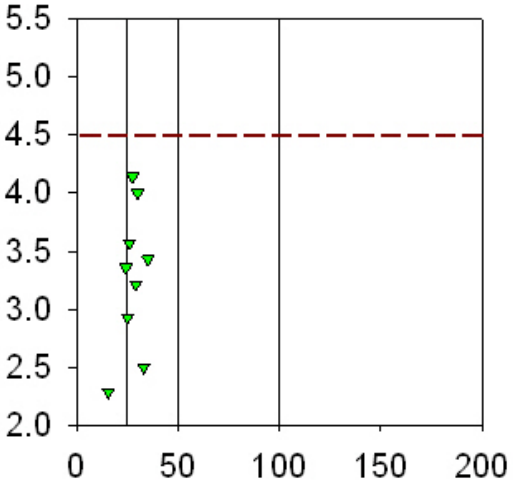


Northern Piedmont

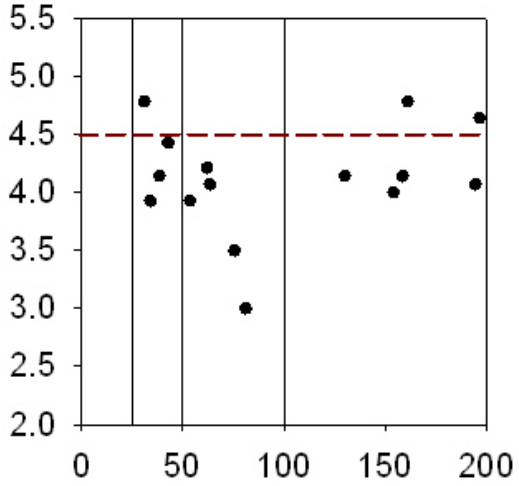


50 ug/L

Outer Coastal Plain



Inner Coastal Plain



50-100 ug/L ?? complex

TP µg / L

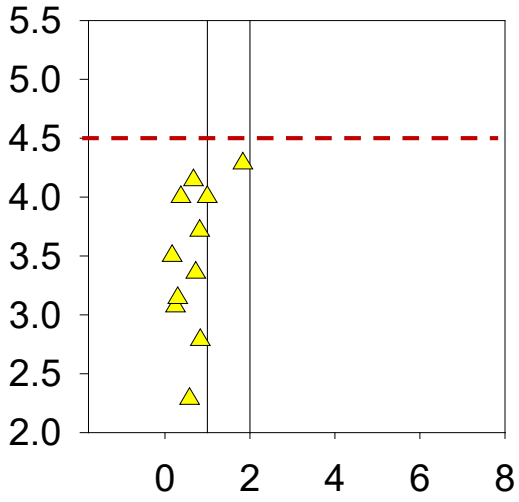
Nutrient criteria options

< 1 mg/L

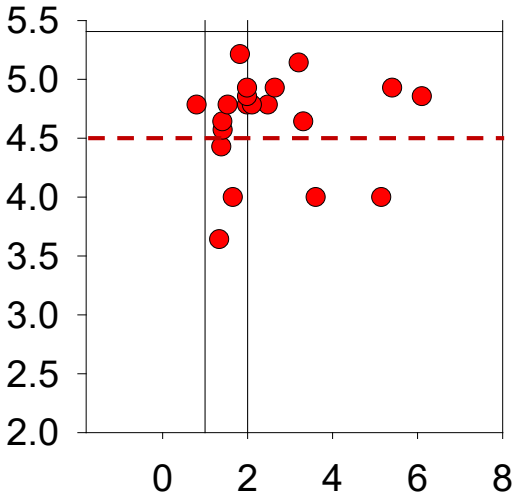
Ave. Diatom Workshop BCG Score

1 - 2 mg/L ?

Ridge and Valley / Northern Highlands

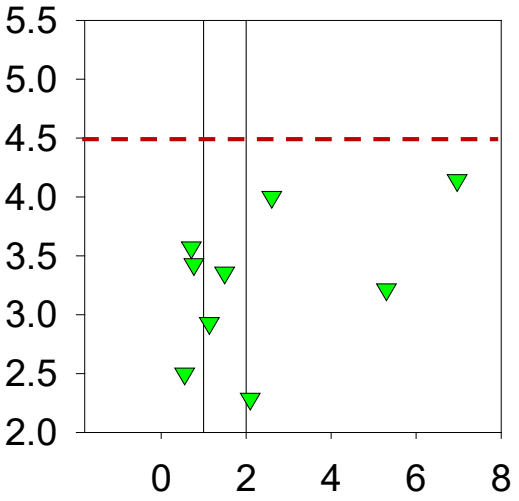


Northern Piedmont

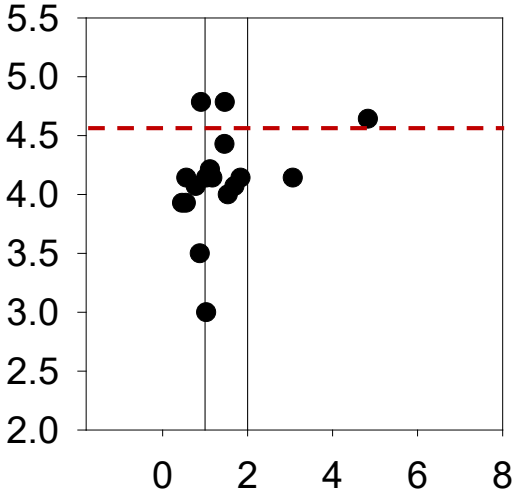


1 – 1.5 mg/L

Outer Coastal Plain



Inner Coastal Plain



1 - 2 mg/L

TN mg/L

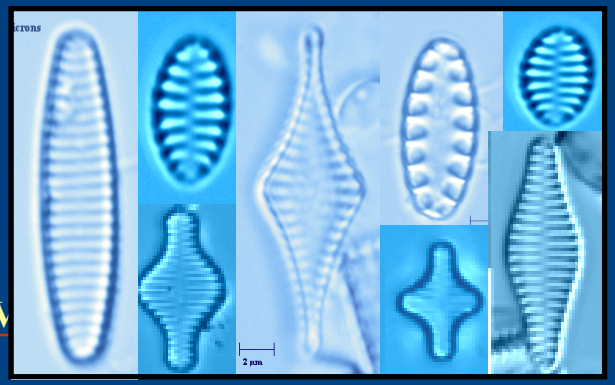
Paleoliminological Analysis of Nutrients and Diatoms in Lake Sediments

TOP

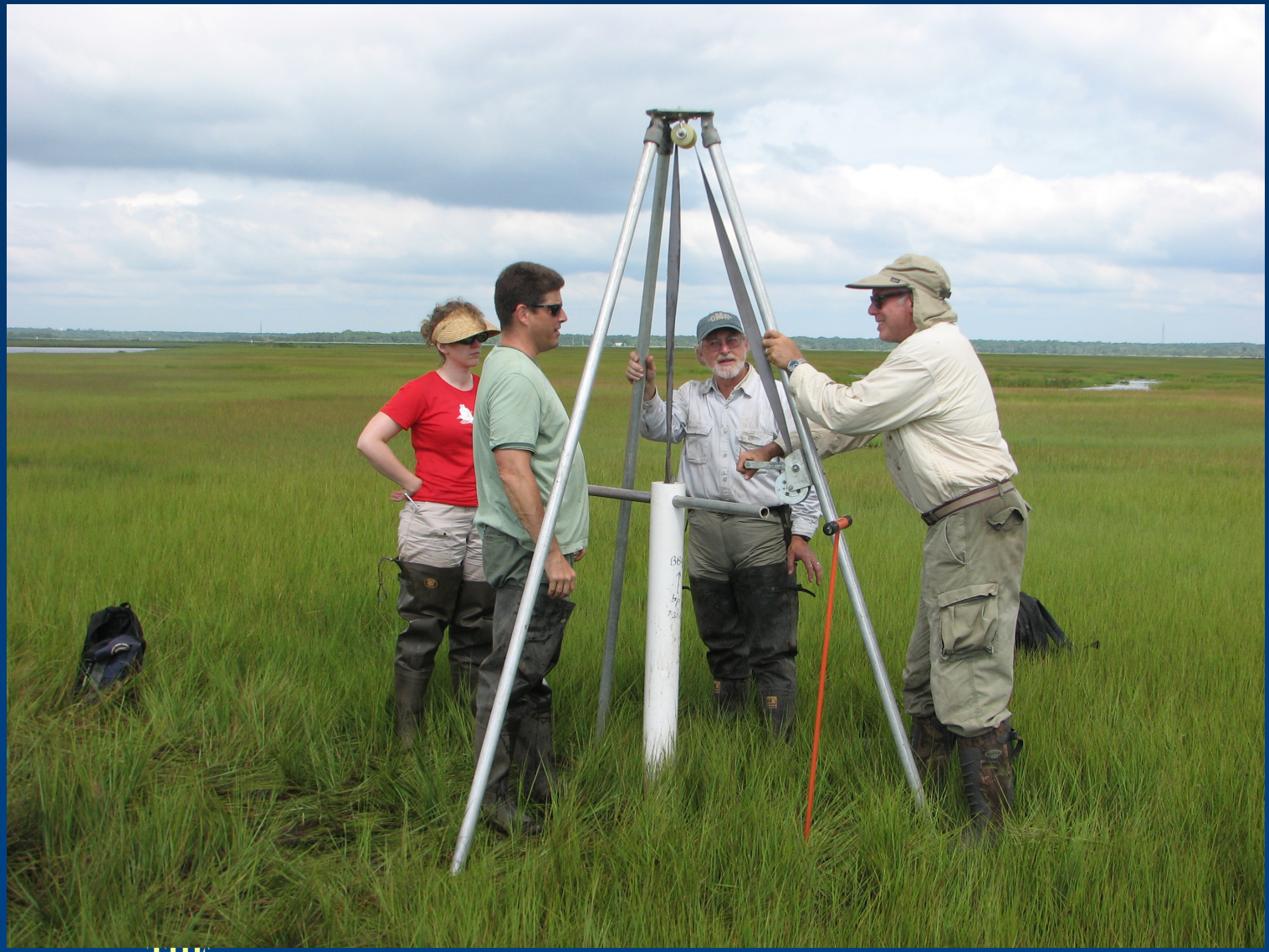
Deposited in recent lake environment

BOTTOM

Deposited in pre-industrial lake environment



Nutrient and Ecological Histories in Barnegat Bay, New Jersey



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NJDEP Nutrient Criteria Development Research (2000 – 2010)*

A. Wadeable Streams

1. Rapid Bioassessment Protocol for Algae as an Indicator of Stream Eutrophication ($400,354)

Ponader, K.C., Charles, D.F., Belton, T.J. and Winter, D.M. 2008. Total phosphorus inference models and indices for coastal plain streams based on benthic diatom assemblages from artificial substrates. Hydrobiologia, Volume 610, Number 1: 139-152.

Ponader, K.C. Charles, D.F. and T.J. Belton. 2007. Diatom-Based TP and TN Inference Models and Indices for Monitoring Nutrient Enrichment of New Jersey Streams, Ecological Indicators, Vol. 7, pp 79-93.

2. Validation of a Macroinvertebrate-Based Index of Nutrient Status in Streams using New Jersey Macroinvertebrate, Water Chemistry, and Diatom Data.($45,000)

Horwitz, R.J., Tuccillo, A., Charles, D.F., Moser, S. and T J. Belton, 2010, Validation of a Macroinvertebrate-Based Index of Nutrient Status in Streams using New Jersey Macroinvertebrate, Water Chemistry, and Diatom Data, Ecological Indicators, (Submitted).

3. Tiered Aquatic Life Use (TALU) Evaluation of New Jersey's Diatom Trophic Index ($70,000) Manuscript in Preparation

4. Systems Ecology Evaluation of USEPA Rapid Bioassessment Protocols in New Jersey (Macroinvertebrates, Periphyton, Fish, Habitat) $195,519

*Flinders, C.A., Horwitz, R.J., and Belton, **T.** 2008. Relationship of fish and macroinvertebrate communities in the mid-Atlantic uplands: implications for integrated assessments, Ecological Indicators, Volume 8, Issue 5, September 2008, Pages 588-598.*

B. Lakes

Paleoliminological Analysis of Nutrient Enrichment for Criteria Development in New Jersey and New York Lakes ($98,000) Manuscript in Preparation

C. Estuaries

Nutrient and Ecological Histories in Barnegat Bay, New Jersey ($90,000) Manuscript in Preparation

* All Projects performed for NJDEP by the Patrick Center for Environmental Research, Academy of Natural Sciences of Philadelphia, PA.

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Development of 2010 Narrative Nutrient Assessment Method

- Weight of evidence approach is needed
- Critical to incorporate biological conditions (benthics, diurnal DO)
- A single statewide numeric criterion may not be appropriate
- 2009 – proposed method in 2010 Water Quality Monitoring and Assessment Methods for developing 2010 Integrated Report (303(d) 305(b))

2010 Narrative Nutrient Criteria Example Assessment Results

Benthic Index Assessment	DO Criteria	Diurnal DO Swing	Narrative Nutrient Criteria
Not Impaired	Met		Met
Impaired	Exceeded	> 3 mg/L	Exceeded*
Impaired	Met	> 3 mg/L	Exceeded* if Chl *a* > 150 mg/sq meter

***Where narrative nutrient criteria exceeded – phosphorus is listed on the 303(d) list**